

The important influence of cuticular wax and epidermal hairs upon transpiration is also discussed.

In Section IV. the mechanical system is considered. With much of the subject-matter of this section we have been acquainted since the appearance of Schwendener's classic "Das mechanische Princip;" but it is of interest to note that in the fungi, *e.g.* *Usnea barbata*, evidence exists of a mechanical tissue which in the higher plants takes the form of sclerenchyma, collenchyma, and bast. The absorptive system includes roots, rhizoids, and like structures; attention being also drawn to the absorptive tissue of the scutellum. This organ in *Briza minor* is peculiar on account of the pronounced development of the absorptive cells, and their striking resemblance to root hairs.

Section VII. deals with the assimilative system, and one is much struck by the marked manner in which the whole structure of the leaf illustrates the principles of which Dr. Haberlandt is the exponent. The palisade layers are naturally regarded as being the chief seat of assimilative activity, and it is pointed out that the cells below these layers, which are of the nature of spongy parenchyma, and contain comparatively few chlorophyll grains, are distinguished by the remarkable manner in which they abut on to the palisade cells. Their special function appears to be to conduct or absorb the products of assimilation, and to be the means of conveying them to other parts of the plant. They are in consequence designated as receptive or conducting cells (Aufnahme oder Sammelzellen). The infoldings which occur in numerous palisade cells and are so well developed in the leaf of the various species of *Pinus*, have for their object the increasing of surface-area, and consequently also the number of chlorophyll grains in the cell.

Some space is devoted to the consideration of the conducting system, which includes the parenchyma of the cortex and pith, the medullary ray parenchyma, &c., the vascular bundles and laticiferous tissue.

Dealing with the vascular bundles from the point of view of physiological anatomy, a special terminology has been adopted. The whole bundle is known as the Mestom, the xylem as the Hadrom, and the phloem as the Leptom. The idea of Mestom includes purely vascular tissue, and excludes the mechanical sclerenchymatous and fibrous tissue (stereom), consisting usually of prosenchymatous cells (sterēides), such as occur accompanying the bundles of most monocotyledons. Dr. Haberlandt's experiments demonstrate that in the moss stem the central strand of tissue is to be regarded as consisting of rudimentary hadrom, having for its function the conduction of water. To the layer surrounding the vascular bundle in roots, &c. (endodermis of De Bary) is applied the term "protective sheath," or "protective layer," on account of its function with relation to the bundle.

For a more complete understanding of the nature of laticiferous tissue we are again indebted to Dr. Haberlandt, whose observations upon this point appear to be of extreme importance. These observations demonstrate that in many of the thick-leaved Euphorbias, those portions of the laticiferous cells which enter the leaf become repeatedly branched in the leaf-tissue, and in such a manner that the extremities or blind ends of these

branches abut directly on to the palisade parenchyma cells, and are thus brought into the closest possible relation with the seat of greatest assimilative activity. The natural inference as to the function of laticiferous tissue has consequently everything to be said in its favour.

In Section IX. the intercellular space system is dealt with, and the various forms of stomata and their mechanism described. Much importance must necessarily be attached to this system when one bears in mind the relation of transpiration and gaseous diffusion to plant-life. The remaining sections are devoted to the secretory and excretory organs, and to the phenomena attending the normal and abnormal mode of increase in thickness of the stem and root.

The few remarks that have already been made are sufficient to show that the book contains numerous points of much interest. It is, moreover, carefully written, and furnished with a copious bibliography.

We cannot conclude this review without pointing out as Dr. Haberlandt has so fitly done, the importance of recognising that in every system there is not only the chief, but also the subsidiary, function, and that in considering any one of them which is especially significant, the less pronounced but still existing functions must be kept in mind. By such means alone will the true advance of physiological anatomy be maintained.

W. G.

WILLIAM HEDLEY

William Hedley, the Inventor of Railway Locomotion on the Present Principle. By M. Archer. Third Edition. (London: Crosby Lockwood and Co., 1885.)

IN this little book the author endeavours to place on record more exact facts with regard to the invention of the locomotive, and to give prominence to the name of the man who first made the locomotive a practical and financial success.

Richard Trevithick is perhaps the only man, before Hedley's time, who narrowly missed the fame now accredited to Stephenson and Hedley. In 1808 Trevithick constructed a circular railway in a field, now forming the southern half of Euston Square. On this railway he placed a locomotive of his own construction, having flanged wheels, a tubular boiler, and a vertical cylinder, driving by means of a cross head the hinder pair of wheels. This engine was attached to a coach, and the few people who would venture in it were taken round the railway at so much per head. After running for a few weeks, a rail broke, causing the engine to leave the rails, and turn over on its side. At this time Trevithick had expended all his means, and was compelled to give up his endeavours to convince the public of the many advantages to be obtained from the use of the locomotive; had he been backed up by influential men, no doubt he would now be known to fame as its inventor.

Many men before Hedley's time had tried their utmost to make a workable locomotive, such as would supersede horses on a colliery railway. Trevithick, Blenkinsop, and Chapman all exercised great ingenuity in their designs, but success was as far off as ever, owing to the general idea prevailing that some mechanical connection must exist between the engine and the railway, believing

that the mere adhesion between the smooth wheels and smooth rails was completely insufficient to prevent slipping.

In the year 1812 William Hedley was viewer at the Wylam Colliery, and in order to reduce the working expenses he endeavoured to construct an engine to haul the coal waggons from the colliery to the river, and to do it cheaper than by horse haulage. At this time he had a knowledge of what others had done in this direction, but was forcibly impressed with the idea that the weight of an engine was sufficient for the purpose of enabling it to draw a train of loaded waggons. After having made successful experiments to prove the idea correct, he set to work and constructed his first engine, which, when completed, did not prove a success owing to shortness of steam, and a second one was made. The second one, the well-known "Puffing Billy," was put to work in May, 1813, and was a complete success. This may be safely called the first practical and efficient locomotive ever constructed. It had a return-tube boiler of wrought iron, vertical cylinders, and was placed on four wheels. Very soon after the engine commenced to work the exhaust steam was turned into the chimney to create a blast on the fire. This engine worked nearly continuously until 1862, when it was bought, and has now found an honourable resting-place in South Kensington Museum.

Puffing Billy was put to work in 1813, nearly a year before Stephenson's first engine was tried at Killingworth in 1814, thus proving without doubt that William Hedley was the first man to construct the first practically successful locomotive engine, and the first economical substitute for animal power.

It should not be thought that our author claims for Hedley the fame of being the first to develop the railways. Puffing Billy was at work sixteen years before the celebrated Rainhill contest took place, and ten years before locomotives were allowed to work the goods traffic on the Stockton and Darlington Railway.

Stephenson's success may be dated from the Rainhill contest in 1825; and he was one of the first men to bring the present railway system forward and develop it. At the same time William James must not be forgotten; he surveyed the Manchester and Liverpool Railway before Stephenson was placed in charge of the Railway Works, and had it not been for a difference of opinion on certain technical points, William James would have been the engineer of the line until open for traffic. Again, William James went to see Stephenson's engine, before Stephenson came to Liverpool, finding him an intelligent working man and the engine a success, he brought Stephenson to Liverpool, where he eventually commenced his successful career.

The author is to be congratulated on having proved his case, and in the preface he truly says: "Without William Hedley, George Stephenson might have lived in vain. It was William Hedley who gave the locomotive its life and power, and made the work of other men possible."

The book is very interesting, and is useful as a book of reference, the appendix containing extracts from the opinions of many writers, and letters from men able to give information on the subject. This little book will prove useful to all who wish to know the facts concerning William Hedley and his inventions.

N. J. L.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Shotfiring in Mines

FOR some time past I have been conducting a series of shotfiring experiments at Dowlais and elsewhere on behalf of the Royal Commission on Accidents in Mines. Towards the end of August last Prof. C. G. Kreischer, of Freiberg in Saxony, visited me at Cardiff for the purpose of conferring with me on the coal-dust question. The experiments at Dowlais have a direct bearing on that subject, so, after pointing out to Prof. Kreischer the perfectly private nature of the investigation and the delicate position in which I would be placed were the results allowed to transpire through any channel other than the Royal Commission, and having received his assurance that such a contingency was impossible as far as he was concerned, I asked him to accompany me to Dowlais, so that he might witness some of the experiments on August 28 and September 1.

On the second (?) day Prof. Kreischer asked my permission to write to his friends in Germany, suggesting that they might make a few similar experiments privately in an apparatus that had been set up at Zwickau, at the expense of the Saxon Government, for the purpose of conducting a series of experiments with coal-dust. He again assured me that no publication of results would take place until after those obtained here were made known, and offered, if I had the least doubt as to the integrity of his friends, not to put it in their power to anticipate our results by not writing to them at all.

I did not feel justified in resisting such an appeal to my trustfulness, and agreed to his proposal.

A few days ago I received the following letter, which I shall be glad if you will kindly publish, along with my answer.

Sir F. A. Abel is the inventor of the dynamite water-cartridge, and not myself, as might be inferred from the article in *Glückauf*.

W. GALLOWAY

Freiburg, October 2, 1885

HOCHGEEHRTER FREUND.—Es war mir unmöglich wieder nach Cardiff zurückzukehren da wir uns zu lange im Durhamreviere aufgehalten hatten und die Zeit meiner zulässigen Bleibens in England sich allzusehr dem Ende zuneigte. Leider bin ich dadurch um das Vergnügen gekommen noch einmal mit Ihnen persönlich verkehren zu können, doch hoffe ich, dass wir uns bald einmal wieder sehen, vielleicht in Zwickau.

Die Schiessversuche mit Wasserbesatz und Pulver—der Versuchsstrecke haben sowohl in Zwickau als auch in Neunkirchen zu guten Resultaten in so fern geführt als die Gasen nicht entzündet wurden. Versuche mit Pulver und Wasserbesatz in der Planitzer Kohle ergeben aber in so fern keine guten Resultate, als die Schüsse nicht werfen.

Leider hat Assessor Nonne, welcher den Versuchen beiwohnte, ganz gegen unsere Verabredung sogleich die Resultate dieser ersten Versuche in einer kurzen Notiz im *Glückauf* veröffentlicht, jedoch ohne ihre Priorität zu nah zu treten, da Sie besonders darin erwähnt sind. Ich hatte ausdrücklich vor jeder Publication gewarnt ehe die Ihrige nicht erschienen sei, ein ordinärer Character kümmert sich aber um so etwas nicht.

Bei späterer Veröffentlichung der Zwickauer Versuche kann eventuel darauf Bezug genommen werden.

Nochmals für alle Liebe und Freundschaft, die sie mir so vielfältig erwiesen haben bestens dankend,

Verbleibe ich mit herzlichem Glückauf,

Ihr,

Ergebenster,

C. G. KREISCHER

Herrn Bergingenieur Galloway, Cardiff

Cardiff, October 9, 1885

DEAR PROFESSOR KREISCHER,—I have received your letter of the 2nd inst. I observe that the friends to whom you sent a description of the shot-firing experiments have violated the conditions under which I gave you permission to make your communication to them by already publishing their results, as if